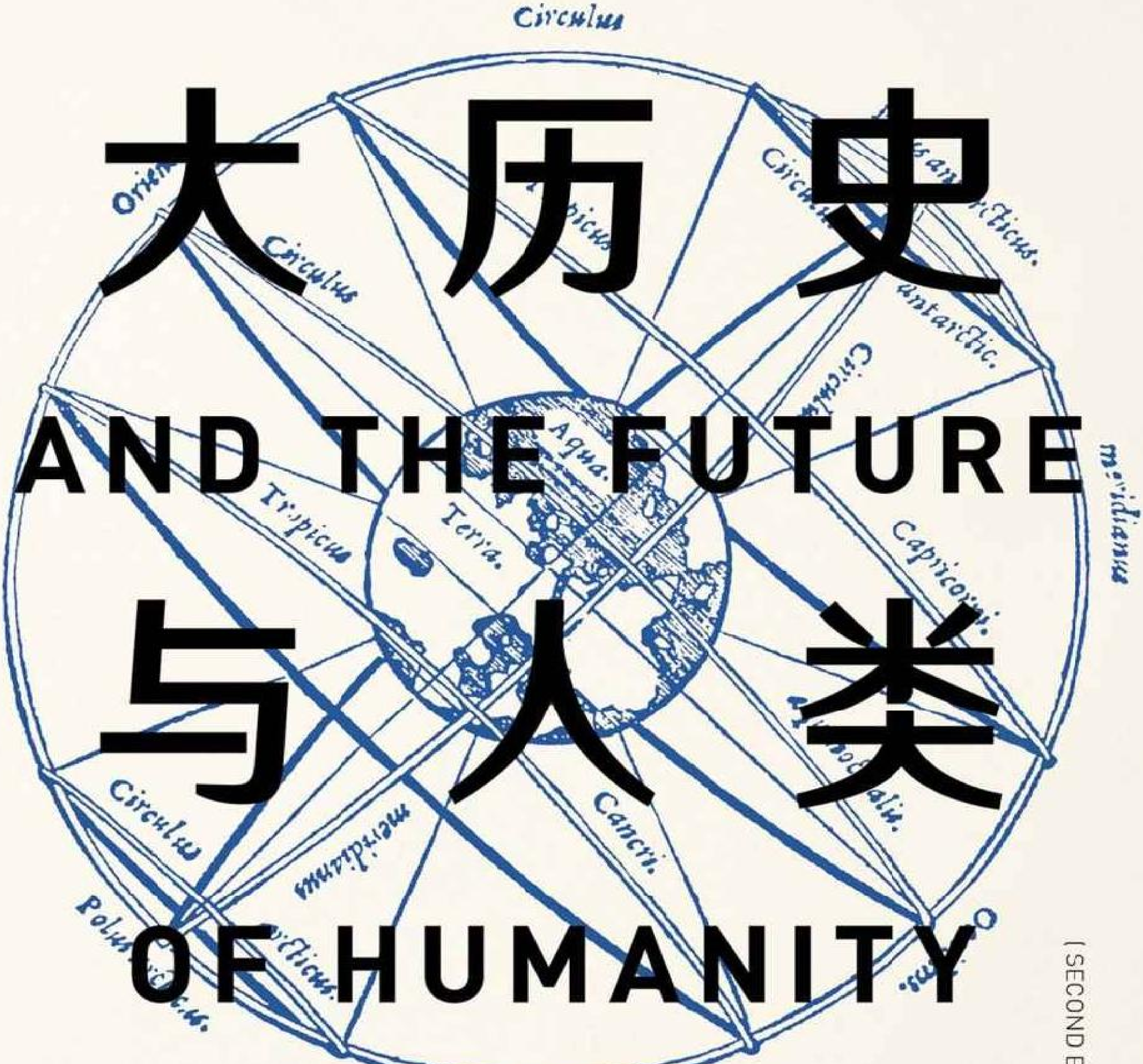
BIG HISTORY



大历史与人类的未来

AND THE FUTURE OF HUMANITY

(SECOND EDITION)（修订版）

FRED SPIER

[荷] 弗雷德·斯皮尔 —————— 著

孙岳 —————— 译

中信出版集团

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> ——[illegible]8[illegible]·[illegible]William Anders[illegible]
> [illegible]Chaikin & Kohl (2009)[illegible]p. 158

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[illegible]——[illegible]——[illegible]20[illegible]60[illegible]70[illegible]1968[illegible]12[illegible]8[illegible]10[illegible]“[illegible]”[illegible]the good Earth[illegible]8[illegible]·[illegible]Frank Borman[illegible]

[illegible]1969[illegible]1[illegible]10[illegible]“[illegible]”[illegible]“[illegible]”[illegible]Earthrise[illegible]“[illegible]”[illegible]“[illegible]”[illegible]“[illegible]”[illegible]“[illegible]8[illegible]”[illegible]

[illegible][1][illegible]1970[illegible]

1970[illegible]·[illegible]Dennis Meadows[illegible]*The Limits to Growth: A Reporot for the Club of Rome Project on the Predicament of Mankind*[illegible]·[illegible]Frits Böttcher[illegible][2]

[illegible]——[illegible]——[illegible][3][illegible]

[illegible]deep history[illegible]20[illegible]60[illegible]

[illegible]detached overview[illegible]——[illegible]

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[illegible]“[illegible]”[illegible]Gaiapolis[illegible]1979[illegible]·[illegible]Joachim Theis[illegible]·[illegible]·[illegible]·[illegible]Leony van der Splinter[illegible]·[illegible]Marvin Harris[illegible]·[illegible]·[illegible]*Culture, People,Nature*[illegible]1988[illegible]

[illegible]20[illegible]80[illegible]90[illegible]Cusco[illegible]·[illegible]·[illegible]·[illegible]·[illegible]San Nicolás de Bari de Zurite[illegible]

[illegible]·[illegible]Mart Bax[illegible]·[illegible]Norbert Elias[illegible]·[illegible]Johan Goudsblom[illegible][5][illegible]

[illegible]1992[illegible]·[illegible]1992[illegible]·[illegible]David Christian[illegible]1993[illegible]·[illegible]

1994

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1992 11 · William H. McNeill ·

1994 *The Structure of Big History,* 1996 1996 10 Santa Fe Institute complexity studies 2000 · Eric Chaisson

2003 2 Gina 2005 *Social Evolution & History* “How big history works: energy flows and the rise and demise of complexity”

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Rodrigue · Jeanine Meerburg

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[1] [illegible]MacLeish (1968); Goldberg (1991), pp. 52-57; Allen, Tainter & Hoekstra (2003), pp. 1-2; '50 years in space: My favourite photo,' p. 40 and Poole (2008)[illegible]Spier (2012)[illegible]

[2] B.ttcher in Meadows (1972), p. 7.

[3] B.ttcher, King, Okita et al. in Meadows (1972), p. 15. [illegible]1972[illegible]

[4] [illegible]Ledeboer, Kroll, Dons et al. (1976)[illegible]

[5] [illegible]Spier (1994 & 1995)[illegible]

[6] [illegible]Spier (2005)[illegible]

[illegible]

ABB[illegible]

BP[illegible]“[illegible]”[illegible]1950[illegible]

CE[illegible]=AD[illegible]

X[illegible]X[illegible]2015[illegible]

时　间	事　件
138 亿年 BP	“大爆炸”
4 分钟 ABB	基本粒子（质子、中子、电子和中微子）出现
4 至 15 分钟 ABB	氘、氦、锂和铍的核合成
5 万年 ABB	从辐射期向物质期的转变
38 万年 ABB	宇宙中和与宇宙背景辐射的出现
7 亿至 20 亿年 ABB	星系和恒星出现
46 亿年 BP	太阳系出现
46 亿至 45 亿年 BP	近日行星出现
45 亿至 39 亿年 BP	冥古宙，包括宇宙轰击
38 亿至 45 亿年 BP	生命涌现
34 亿年 BP	最古老的叠层石与光合作用的出现
20 亿年 BP	大气和真核细胞中游离氧的出现
5.4 亿年 BP	寒武纪复杂生命形式的大爆发

4 亿年 BP	生命向陆地迁移
2 亿年 BP	恒温（温血）动物出现
6,500 万年 BP	据说小行星撞击结束了恐龙的统治，为哺乳动物创造了生存空间
400 万年 BP	双足行走的南方古猿出现
200 万年 BP	直立人出现
20 万年 BP	智人出现
1 万年 BP	农业的出现
6,000 年 BP	最早的国家出现
500 年前	第一波的全球化浪潮
250 年前	第二波的全球化浪潮（工业化）
70 年前	第三波的全球化浪潮（信息化）

[illegible]

[illegible]

[illegible]

[illegible]“[illegible]”[illegible]

“[illegible]”[illegible]·[illegible]1946— [illegible][1][illegible]20[illegible]80[illegible]1994[illegible]

[illegible]200[illegible]20[illegible]80[illegible]

[illegible]·[illegible]1946— [illegible]

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[illegible]·[illegible]（Donald Ostrowski, 1945— [illegible]“[illegible]”[2][illegible][3][illegible]

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[illegible]·[illegible]（Bill Bryson, 1951— [illegible]*A Short History of Nearly Everything*[illegible]·[illegible]130[illegible]*Maps of Time: An Introduction to Big History*[illegible]

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[illegible] Beresheet/Genesis [illegible]

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[illegible]·[illegible]·[illegible] *The Pursuit of Truth: A Historian’ s Memoir* [illegible] 2005 [illegible] 32—33 [illegible]

[illegible] trial and error [illegible]

[illegible]·[illegible]·[illegible] Alexander von Humboldt [illegible] *Cosmos,* 1866 [illegible] “[illegible]” [illegible] 1000 [illegible] 1500 [illegible]

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[illegible]“[illegible]”[illegible]·[illegible]Robert Poole[illegible]1957— [illegible]*Earthrise: How Man First Saw The Earth*, 2008[illegible]·[illegible]·[illegible]·[illegible]Denis Cosgrove[illegible]1948—2008[illegible]*A pollo’s Eye: A Cartographic Genealogy of the Eerth in the Western Imagination*[illegible]2001[illegible]

[illegible]1928[illegible]·[illegible]Alexander Fleming[illegible]1881—1955[illegible]·[illegible]·[illegible]Vesto Melvin Slipher[illegible]1875—1969[illegible]1913[illegible]“[illegible]”[illegible]20[illegible]20[illegible]·[illegible]·[illegible]Edwin Powell Hubble[illegible]1889—1953[illegible]

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[illegible]1[illegible]46[illegible]

[illegible]——[illegible]138[illegible]——[illegible]

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1845[illegible]·[illegible]·[illegible][6][illegible]

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[illegible]“[illegible]”[illegible]Cuzco[illegible]

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[illegible]“[illegible]”[illegible]mappae mundi[illegible]1300[illegible]Hereford mappa mundi[illegible]“[illegible]”[illegible]“[illegible]”[illegible]·[illegible]Johannes Gutenberg[illegible]1395—1468[illegible]1450[illegible]“[illegible]”[illegible]1544[illegible]*Cosmographia*[illegible]·[illegible]Sebastian Münster[illegible]1488—1552[illegible]15[illegible]Ptolemy[illegible]

[illegible]·[illegible]Ranulphus Higden[illegible]1280—1364[illegible]1330[illegible]1360[illegible]*Polychronicon*[illegible]19[illegible]·[illegible]

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[illegible]19[illegible]“[illegible]”[illegible]·[illegible]Titus Livy[illegible]59[illegible]—[illegible]17[illegible]“[illegible]”[illegible][10][illegible]

[illegible]“[illegible]”[illegible]“[illegible]”[illegible]“[illegible]”[illegible]prehistory[illegible][11][illegible]·[illegible]Dan Smail[illegible]1961— [illegible]2005[illegible]6,000[illegible]·[illegible]·[illegible]James Ussher[illegible]1581—1656[illegible]1654[illegible]4004[illegible]·[illegible]“[illegible]”[illegible][12]

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[illegible]1840[illegible]·[illegible]Joseph E. Worcester[illegible]1784—1865[illegible]1850[illegible]“[illegible]”[illegible]5[illegible]

[illegible]

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[illegible]“[illegible]”[illegible]

[illegible]“[illegible]”[illegible]

[illegible]——[illegible]·[illegible]Fernand Braudel[illegible]1902—1985[illegible]——[illegible]20[illegible]70[illegible]80[illegible]

[illegible]19—20[illegible]“[illegible]”[illegible]

[illegible]·[illegible]·[illegible]Leopold von Ranke[illegible]1795—1886[illegible]“[illegible]”[illegible]Weltgeschichte[illegible]“[illegible]”[illegible]Universalgeschichte[illegible][13] [illegible]·[illegible]·[illegible]·[illegible]——[illegible]·[illegible]·[illegible]·[illegible]“[illegible]”[illegible]“[illegible]”[illegible]

20[illegible]·[illegible]·[illegible]Arnold Joseph Toynbee[illegible]1889—1975[illegible]H. G. Wells[illegible]1866—1946[illegible]·[illegible]Geoffrey

Barraclough[illegible]1908—1984[illegible]1955[illegible]“[illegible]”[illegible][14]

[illegible]20[illegible]·[illegible]L.S. [illegible]Leften S. Stavrianos[illegible]1913—2004[illegible]·[illegible]John Roberts[illegible]1928—2003[illegible]*History of the World*[illegible]·[illegible]·[illegible]Bob Moore[illegible]1941— [illegible]20[illegible]80[illegible]“[illegible]”[illegible]

21[illegible]·[illegible]·[illegible]John R. McNeill[illegible]1954— [illegible]2003[illegible]*The Human Web*[illegible]*The Rise of the West,*1963[illegible]1992[illegible]

[illegible]50[illegible]

[illegible]“[illegible]”

[illegible]·[illegible]Gerardus Vossius[illegible]1632[illegible]1[illegible]“[illegible]”[illegible]Atheneum Illustre[illegible]“[illegible]”[illegible]·[illegible]1577—1649[illegible]·[illegible]Caspar Barlaeus[illegible]1584—1648[illegible]

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[illegible]1994[illegible]

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[illegible]*Kosmos*[illegible]“[illegible]”[illegible]a cosmical history of the universe[illegible][16][illegible]1845[illegible][17]

> [illegible]……[illegible]

1825[illegible]1826[illegible]Marquis de Montauban[illegible]1827[illegible]61[illegible]Berliner Singakademie[illegible]16[illegible][18][illegible]

[illegible]19[illegible]·[illegible]Charles Darwin[illegible]1809—1882[illegible]·[illegible]·[illegible]Alfred Russel Wallace[illegible]1823—1913[illegible]*On the Origin of Species*[illegible]6[illegible]

[illegible]1.1[illegible]·[illegible]·[illegible]·[illegible]Robert Chambers[illegible]·[illegible]·[illegible]·[illegible]James Lovelock[illegible][19][illegible]



[illegible]1.1 [illegible]·[illegible]·[illegible]Alexander von Humboldt[illegible]67[illegible]·[illegible]Eduard Hildebrandt[illegible]1856[illegible]

[illegible]18[illegible]·[illegible]·[illegible]·[illegible]Aimé Jacques Alexandre Bonpland[illegible]1773—1858[illegible]5[illegible]29[illegible]1799[illegible]6[illegible]5[illegible][20][illegible]

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[illegible]·[illegible]·[illegible]Paul-Henri Thiry Baron d’ Holbach,1723—1789[illegible]*Encyclopédie*[illegible]1770[illegible]*Système de la nature ou des loix du monde physique et du monde moral*[illegible]·[illegible]·[illegible]·[illegible]Jean-Baptiste de Mirabaud[illegible]·[illegible]Thomas Jefferson[illegible]“[illegible]”[illegible]1776[illegible][22][illegible]

[illegible]1664[illegible]·[illegible]René Descartes[illegible]1596—1650[illegible]

[illegible]*Le Monde, ou, Traité de la lumière*[illegible]1755[illegible]·[illegible]Immanuel Kant[illegible]1724—1804[illegible]1784[illegible]——[illegible]——[illegible]“[illegible]”[23][illegible]·[illegible]·[illegible]·[illegible]Georg Wilhelm Friedrich Hegel[illegible]1770—1831[illegible]1817[illegible]*Enzyklopädie der philosophischen Wissenschaften im Grundrisse*[illegible][24]

[illegible]·[illegible]Robert Chambers[illegible]1802—1871[illegible]·[illegible]·[illegible]1844[illegible]·[illegible]John Churchill[illegible]*Vestiges of the Natural History of Creation*[illegible][25]

[illegible]·[illegible]James Secord[illegible]1953— [illegible][26][illegible][27][illegible]1884[illegible]

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[illegible]·[illegible]Harlow Shapley[illegible]1885—1972[illegible]·[illegible]Robert Jastrow[illegible]1925—2008[illegible]·[illegible]Guy Dingemans[illegible]1958[illegible]*The Tragedy of the Universe: Formation and Trans for mation of the Continents, the Universe, Life, Species, Races, Mankind*[illegible][30]

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[illegible]1986[illegible]·[illegible]*L’ heure de s’ enivrer: L’univers a-t-il un sens?*[illegible]1991[illegible]*The Hour of Our Delight: Cosmic Evolution,Order, and Complexity*[illegible]

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[illegible]·[illegible]Jan Zalasiewicz[illegible]1954— [illegible]*The Planet in a Pebble*,2010[illegible]·[illegible]Neil Shubin[illegible]1960— [illegible]*The Universe Within: The Deep History of the Human Body*,2013[illegible]2[illegible]2013[illegible]

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[4] [illegible]William McNeill (1986a&b)[illegible]David Christian (2004)[illegible]

[5] [illegible]“[illegible]15[illegible]”[illegible]

[6] Von Humboldt (1997), p. 153, [illegible] (1845), p. 160[illegible]

[7] [illegible]“[illegible]”[illegible]

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[9] [illegible]Christian (2010)[illegible]

[10] [illegible]Moore (1997)[illegible]

[11] [illegible]“[illegible]”[illegible]literacy[illegible]·[illegible]Eric Wolf[illegible]1923—1999[illegible]Europe and the People without History, 1982[illegible]

[12] [illegible]Smail (2005 & 2007)[illegible]The Annals of the World[illegible]70[illegible]

[13] Leopold von Ranke: ‘A Fragment from the 1860’s,’ in Stern (1956). [illegible]von Ranke (1888), pp. xv-xvi[illegible]·[illegible]

[14] Barraclough (1955), pp. 17.. [illegible]2008[illegible]·[illegible]Patrick O’Brien[illegible]20[illegible]70[illegible]“[illegible]”[illegible](2008), p. 1[illegible]

[15] [illegible]·[illegible]·[illegible]Ette & Lubrich (2004), Helferich (2004), Sachs (2007), Walls (2009)[illegible]

[16] Von Humboldt (1997), p. 340.

[17] [illegible]von Humboldt (1995) and Kosmos: Entwurf einer physischen Weltbeschreibung (1845[illegible]1862[illegible]), [illegible]Cosmos (1997)[illegible]Helferich (2004)[illegible]Cosmos (1997), pp. 55-56 and pp. 79-80[illegible]

[18] [illegible]von Humboldt (1993)[illegible]

[19] [illegible]·[illegible]

[20] Von Humboldt (1995), p. ix. [illegible]

[21] [illegible]

[22] [illegible]Spier (2013)[illegible]

[23] □□Descartes (1977)□Kant (1755 & 1963)□□□□□□□□□□□□□□□□□□□□□□□
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[25] Chambers (1994), pp. 306–10. □Cosmos (1997), pp. 71–2, □□□□□□□□□□□□□□□□□□
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[26] Secord (2000). □□□□□□□□□□·□□□□□□□□□□□□1994□□□□□□□□□□□□□□□
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[28] Wells (1930), p. vi.

[29] □□□□□□□□Christian (2009a&b)□

[30] Shapley (1959, 1963) and Jastrow (1967, 1977).

[31] □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□·□□□Kees Boeke□□□□□□□□□□
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[32] Kuhn (1970).

[33] □□□□□□□□□□ : Verburgh (2007); □□□□ : Vélez (1998); □□ : Reeves (1981, 1986, 1991), Morin and Kern (1993), Reeves, Rosnay, Coppens & Simonnet (1996 & 1998), Nottale, Chaline & Grou (2000) and Perino (2013); Germany: Lesch & Zaun (2008); □□ : Drees (1996 & 2002), Spier (1996, 1998 & 1999a&b, 2010, 2011a&b) and Lange (1997); □□□ : Neprimerov (1992) and Nazaretyan (2001, 2004, 2010); □□ : May, Moore & Lintott (2006), Aunger (2007a&b) and Lloyd (2008); □□ : Chaisson (1977, 1981, 1987, 1988, 1998, 2001, 2003, 2004, 2006, 2008 & 2009), Field, Verschuur & Ponnamperuma (1978),Mears (1986, 2009), Asimov (1987), Kutter (1987), Swimme & Berry (1992), Adams & Laughlin (1999), Morowitz (2002), Gonzalez & Richards (2004) [□□□□□□□□□□□□□□□□□□intelligent design□□□□□□□□□□□□□□], Primack & Abrams (2006), Brown (2007), Gehrels (2007), Genet (2007), Genet, Genet, Swimme, Palmer & Gibler (2009), Potter (2009), Swimme & Tucker (2011), Christian, Brown & Benjamin (2013)□Simon, Behmand & Burke (2014)□

[34] □□McNeill (1992, 1998 & 2001)□1996□□□□□□□□□□□□□□□□□□□□□□□□□
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[35] □□Mears (1986 & 2009), Christian (1991)□□□□□□□□□□□□□□□□□□□□□□□
Spier (2005b)□

[36] □□□□□□□□□□□□□Spier (2011b)□

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通称结构	大致年代（10^9年）	平均Φm值（10^{-4}瓦/千克）
星系（银河系）	12	0.5
恒星（太阳）	10	2
行星（地球）	5	75
植物（生物圈）	3	900
动物（人体）	10^{-2}	20,000
大脑（人头盖骨）	10^{-3}	150,000
社会（现代文化）	0	500,000

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[illegible] [18] [illegible] dark matter [illegible]

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[illegible]·[illegible]Lucas Reijnders[illegible]1946— [illegible]1997[illegible][21][illegible][22]

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[illegible]/[illegible]F-117[illegible][23][illegible]180[illegible]/[illegible]

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[illegible]·[illegible]Murray Gell-Mann[illegible]1929— [illegible]“[illegible]”[illegible][24][illegible]

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[1] Monod (1971).

[2] Von Humboldt (1997), pp. 82-83, □□□□□□1845□, pp. 83-85□

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[5] Chaisson (2001), p. 234.

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[7] Smil (2006), p. 1.

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[13] □□Adams & Laughlin (1999)□

[14] Smil (1999), p. x.

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[17] Chaisson (2001), p. 139. □□□□□□□□□□□□□□erg s–1g–1□□□□□□□□□□10–4□ /□□□□□□□□□□□□□□□□□□□SI□□□□□□□□□□□□Chaisson□2011a□□□□□"□□□□□□"□□□□□□□□"□□"□

[18] Chaisson (2001), pp. 136-139.

[19] Chaisson (2001), p. 186.

[20] Chaisson (2001), p. 138□□□"□□□□□□70□□"□□□□□□□□□"□□□□□2,800□□□□□□□□130□□□□□□□□□□□□□□□"□

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[23] Chaisson (2001), p. 201.

[24] Gell-Mann (1994), p. xiv.

[25] Chaisson (2001), pp. 143-144.

[26] [illegible]Marshall (1998)[illegible]

[27] [illegible]“[illegible]”[illegible]·[illegible]2003[illegible]3[illegible]“How Big History Works”[illegible]“[illegible]‘[illegible]’[illegible]”[illegible]“[illegible]”[illegible]—[illegible]

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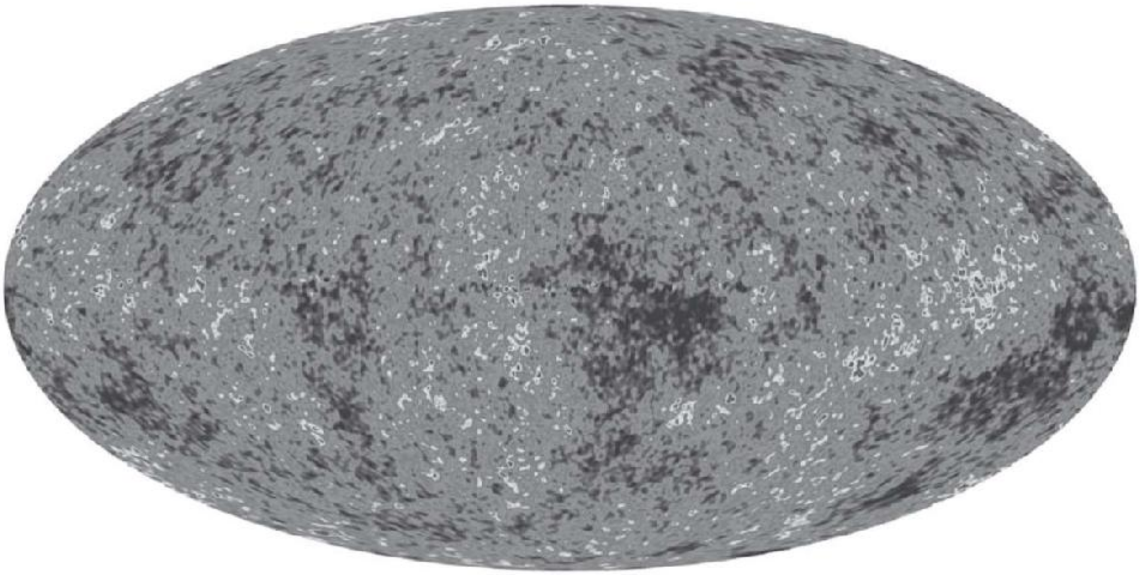
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[1] [illegible]·[illegible]Steven Weinberg[illegible]The First Three Minutes, 1993[illegible]·[illegible]The Self-Organizing Universe, 1983[illegible]·[illegible]Cosmic Evolution, 2001[illegible]Epic of Evolution, 2006[illegible]·[illegible]·[illegible]Steve McMillan[illegible]Astronomy Today, 2008[illegible]·[illegible]David Levy[illegible]The Scientific American Book of the Cosmos, 2000[illegible]·[illegible]Armand Delsemme[illegible]Our Cosmic Origins, 1998[illegible]·[illegible]"[illegible]"[illegible] www.cfa.harvard.edu/~ejchaisson/cosmic_evolution/docs/splash.html [illegible]·[illegible]Marcia Bartusiak[illegible]The Day We Found the Universe, 2010[illegible]

[2] [illegible]The International System of Units, [illegible]SI[illegible]2006[illegible]113[illegible]"[illegible]"[illegible] -133[illegible]9,192,631,770[illegible]"[illegible]"[illegible]

[3] [illegible]satellite galaxies[illegible]Chown[illegible]2009[illegible]MOND[illegible]Shiga[illegible]2006[illegible]Chown[illegible]2007[illegible]

[4] [illegible]Shiga[illegible]2007[illegible]·[illegible]Chaisson[illegible]2001[illegible], pp. 98-99[illegible]"[illegible]"[illegible]Chown[illegible]2005[illegible]Lerner[illegible]2004[illegible]

[5] "[illegible]"[illegible]·[illegible]·[illegible]1993[illegible]80[illegible]$E=mc^2$[illegible]·[illegible]Ajay Sharma[illegible]2004[illegible]"[illegible]·[illegible]S.T.[illegible]S.T.Preston[illegible]1875[illegible](Poincaré[illegible]1900[illegible]·[illegible]De Pretto[illegible]1903[illegible]·[illegible]F. Hasenöhrl[illegible]$E=D\ mc^2$[illegible]$E=mc^2$[illegible]J.J.[illegible]J.J.Thomson[illegible]1888[illegible]$E=D\ mc^2$[illegible]"

[6] [illegible]·[illegible]1993[illegible]3¾[illegible]110[illegible]·[illegible]1973[illegible]·[illegible]·[illegible]1986[illegible]

[illegible]"[illegible]"[illegible]multiverse[illegible]·[illegible]Sir Martin Rees[illegible]1997[illegible]

[illegible]·[illegible]Subrahmanyan Chandrasekhar[illegible]1910 —1995[illegible]"[illegible]"[illegible]2007[illegible]·[illegible]Tom Gehrels[illegible]1925—2011[illegible]

[illegible]——[illegible]2007 & 2009[illegible]

[7] Chaisson (2001), pp. 110..

[8] Jantsch (1983), pp. 82-89. [illegible]“[illegible]”[illegible]“[illegible]”[illegible]“[illegible]”[illegible]

[9] [illegible]·[illegible]E=hv[illegible]$E = mc^2$[illegible]

[10] Chaisson & McMillan (2008), p. 735.

[11] Chaisson’s Cosmic Evolution website, page ‘First stars.’

[12] [illegible]Chaisson & McMillan[illegible]2008[illegible]pp. 670.[illegible]

[13] Chaisson (2001), p. 126.

[14] [illegible]130[illegible]

[15] Hammer, Puech, Chemin, Flores & Lehnert (2007).

[16] Reeves (1991), p. 80.

[17] Reeves (1991), pp. 72-73.

[18] Jantsch (1983), p. 89.

[19] [illegible]Getman, Feigelson, Luhman, Sicilia-Aguilar, Wang & Garmire (2009)[illegible]

[20] [illegible]Chaisson & McMillan[illegible]2008[illegible]pp. 439.[illegible]

[21] Reeves (1991), p. 106.

[22] Jantsch (1983), p. 91.

[23] [illegible]2×1030[illegible]4×1026[illegible]7×108[illegible]

[24] Chaisson (2001), pp. 148..

[25] Chaisson (2001), p. 150 and p. 240.

[illegible]

[illegible]

[illegible]

——[illegible]·[illegible]·[illegible]1997[illegible]
[illegible]79—80[illegible]1845[illegible]80[illegible]

[illegible]

[illegible]——[illegible]——[illegible]accumulated effects[illegible][1][illegible]collective effects[illegible]——[illegible][2]

[illegible]120[illegible]——[illegible]1,000[illegible]1,000[illegible]——[illegible][3][illegible][4]

[illegible][5]

[illegible]

[illegible]exoplanets[illegible]exosolar planets[illegible]20[illegible]90[illegible]2014[illegible]6[illegible]1,800[illegible]1,100[illegible]

[illegible]

[illegible]——[illegible]100[illegible]

[illegible]

[illegible]20[illegible]70[illegible]

[illegible]

[illegible]“[illegible]”[illegible]80[illegible]30[illegible]

[illegible]·[illegible]Charles Lineweaver[illegible]·[illegible]Yeshe Fenner[illegible]·[illegible]Brad Gibson[illegible]“[illegible]”[illegible]“[illegible]”[illegible][6][illegible]23,000[illegible]30,000[illegible]80[illegible]40[illegible]75%[illegible]50,000[illegible][7][illegible]

> [illegible]metallicity[illegible]……[illegible]80[illegible]68%[illegible]……[illegible]75%[illegible]10[illegible]……[illegible]……[illegible]frequency of grazing impacts with molecular clouds[illegible]corotation circle[illegible]

[illegible]

[illegible]

[illegible]galactic plane[illegible]20[illegible]1,000[illegible]

[illegible]double stars[illegible][8][illegible]

[illegible]

[illegible]1755[illegible]·[illegible][9][illegible]

[illegible]46[illegible][10][illegible]99%[illegible]71%[illegible]27%[illegible]——[illegible]——[illegible]

[illegible]

[illegible]100[illegible]T[illegible]T Tauri wind[illegible]

[illegible]

[illegible]Kuiper belt[illegible]·[illegible]Gerard Kuiper[illegible]1905—1973[illegible]30[illegible]50[illegible]1.5[illegible]Oort Cloud[illegible]·[illegible]Jan Oort[illegible]1900—1992[illegible]50,000[illegible]100,000[illegible]1.5[illegible]4[illegible]

[illegible]accretion heat[illegible]2×10^{32}[illegible]600[illegible][11][illegible]1,200[illegible]2,200[illegible]2,900[illegible]32%[illegible]30%[illegible]15%[illegible]14%[illegible]3%[illegible]2%[illegible]5[illegible]70[illegible]

[illegible]differentiation heat[illegible]10^{31}[illegible][12][illegible]

[illegible]radiogenic heat[illegible]upper mantle[illegible]convection cells[illegible]

[illegible]nuclear heat[illegible]90%[illegible]90%[illegible]6,000 K[illegible]

[illegible]——[illegible]300 K[illegible]——[illegible]

[illegible]

[illegible]

[illegible]——[illegible]——[illegible]6[illegible]

[illegible]cosmic bombardment[illegible]crater[illegible]4[illegible][13]

[illegible]1[illegible]1.5[illegible]“[illegible]”[illegible]66.5[illegible]90[illegible]90[illegible]

[illegible]45.6[illegible]9[illegible]

[illegible]·[illegible]“[illegible]”[14][illegible]

[illegible]——[illegible]——[illegible]·[illegible][15][illegible]chaos theory[illegible]

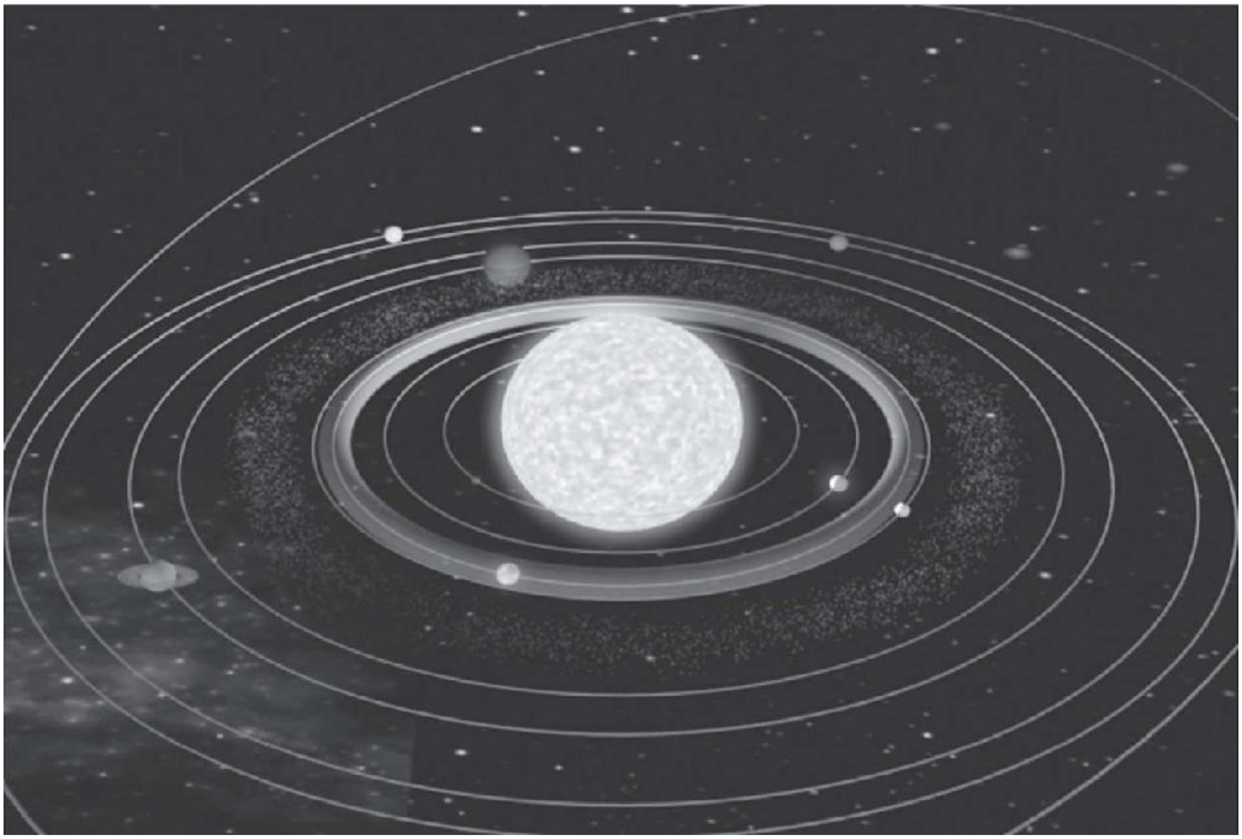
[illegible]

[illegible]——[illegible]——[illegible]habitable zones[illegible]HZ[illegible]1993[illegible]·[illegible]James Kasting[illegible]·[illegible]Daniel Whitmire[illegible]·[illegible]Ray Reynolds[illegible][16][illegible]

[illegible]/[illegible]/[illegible]CO2/H2O/N2[illegible]photolysis[illegible]hydrogen escape[illegible]albedo[[illegible]][illegible]convective lapse rate[[illegible]][illegible]0.95[illegible]1.37[illegible]1[illegible]continuously habitable zone[illegible]CHZ[illegible]0.95~1.15[illegible]

[illegible]——[illegible]——[illegible]4.1[illegible]

[illegible][17]



□4.1 □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□

[illegible]

[illegible] 1 [illegible] 2 [illegible] 3 [illegible] 4 [illegible]

[illegible] —— [illegible] —— [illegible]

[illegible] 45.6 [illegible] [18] [illegible]

[illegible] 40 [illegible] [19]

[illegible] · [illegible] [20]

> [illegible] thermal disequilibrium [illegible] …… [illegible]

> [illegible] ……[illegible] 6,000 K [illegible] 300 K [illegible] 25 [illegible] 77 [illegible] 20 [illegible] 20 [illegible]

[illegible] 87 [illegible]/[illegible] 1,367 [illegible]/[illegible]

[illegible][21] [illegible]

[illegible] 24 [illegible] 6 [illegible] 24 [illegible] 24 [illegible][22]

[illegible]

[illegible][23] [illegible] 78 [illegible]

[illegible] 66.5 [illegible] 1 [illegible] 1.5 [illegible]

[illegible]

[illegible]365.25[illegible]orbital regimes[illegible]10[illegible]“[illegible]”[illegible]eccentricity[illegible]22.1~24.5[illegible]“[illegible]”[illegible]axialtilt[illegible]“[illegible]”[illegible]obliquity of the ecliptic[illegible]4.1[illegible]2.1[illegible]“[illegible]”[illegible]Milanković cycles[illegible]·[illegible]1879—1958[illegible][24][illegible]

[illegible]

[illegible]

[illegible]“[illegible]”[illegible]secondary atmosphere[illegible]——[illegible]——[illegible]

[illegible]25%[illegible]

[illegible]

[illegible]3[illegible]

[illegible]

[illegible]2[illegible]8[illegible]6[illegible]8[illegible]4[illegible]

[illegible]1[illegible]

[illegible]noble gases[illegible]

[illegible]covalent bonds[illegible]1[illegible]

[illegible]

[illegible]0.1[illegible]

[illegible]“[illegible]”[illegible]Hadean Era[illegible]45[illegible]38[illegible]

[illegible]40[illegible]dynamic steady state[illegible]12[illegible]

[illegible]30[illegible]20[illegible]land masses[illegible]20[illegible]10[illegible]20[illegible]East Pacific Rise[illegible]150[illegible][25]

[illegible]90%[illegible]5%[illegible]2%~3%[illegible]150[illegible][26][illegible]free oxygen[illegible]78%[illegible]21%[illegible]1%[illegible]0.04%[illegible]4%[illegible]

[illegible]

2×10^{-4} / 0.09 / 2 /

1895 · [27]

“ ” metabolism

—— —— DNA RNA

[28]

[illegible][29]

[illegible]

[illegible]“[illegible]”[illegible]enzymes[illegible]——[illegible]——[illegible]

[illegible]·[illegible]·[illegible]·[illegible]

[illegible]·[illegible][30]

[illegible]ontogeny[illegible]phylogeny[illegible]

[illegible]

[illegible]

[illegible] DNA [illegible] RNA [illegible] DNA [illegible] RNA [illegible]

[illegible] ribosomes [illegible] RNA [illegible] RNA—— [illegible] RNA —— [illegible] amino acids [illegible] RNA [illegible] RNA [illegible] RNA [illegible] RNA [illegible]

[illegible] RNA [illegible]

[illegible]

[illegible][31][illegible]

[illegible]38[illegible]34[illegible]45.6[illegible]

[illegible]——[illegible]——[illegible]

[illegible]“[illegible]”（chemical evolution）[illegible]

[illegible]·[illegible]——[illegible][32][illegible]1871[illegible]·[illegible]“[illegible]”（warm little pond）[illegible][33]

[illegible]

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[illegible]“RNA[illegible]”[illegible]RNA world[illegible]RNA[illegible]RNA[illegible]RNA[illegible]RNA[illegible]RNA[illegible]RNA[illegible]ATP[illegible]RNA[illegible]RNA[illegible]RNA[illegible][34]

[illegible]“[illegible]”[illegible]·[illegible]50×10^{-4}[illegible]/[illegible]10^{-4}[illegible]/[illegible][35][illegible]·[illegible]2005[illegible]“[illegible]”[illegible][36]

[illegible]·[illegible]Eugene Koonin[illegible]·[illegible]William Martin[illegible]2005[illegible]——[illegible]——RNA[illegible][37][illegible]prokaryotes[illegible]eukaryotes[illegible]DNA[illegible]

[illegible]in-builtdrive[illegible]

[illegible]autocatalysis[illegible]

[illegible]——[illegible]

[illegible]

[illegible]——[illegible][38]

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[1] [illegible]·[illegible] (1987 & 2000)[illegible]

[2] [illegible]

[3] [illegible]Fox (2007)[illegible]

[4] [illegible]Aunger (2007a&b)[illegible]

[5] [illegible]Chaisson (2001 & 2006); Christian (2004); Cloud (1988); Drury (1999); Jantsch (1983); Lovelock (1987 & 2000); Lunine (1999); Priem (1993 & 1997); Smil (1999 & 2002); Ward & Brownlee (2004); and Westbroek (1992)[illegible]

[6] Lineweaver, Fenner & Gibson (2004), pp. 59-62.

[7] [illegible]angular velocity[illegible]23,500[illegible]4,200[illegible]24,500[illegible]Mishurov, Zenina, Dambis, Mel'Nik & Rastorguev (1997), pp. 775-780[illegible]

[8] [illegible]Chown (2008)[illegible]

[9] Kant (1755).

[10] [illegible]Cloud (1988), pp. 10-15[illegible]

[11] [illegible]1.3×10^{21}[illegible]1[illegible] = 0.239[illegible]1[illegible]1[illegible]15.5[illegible]16.5[illegible]

[12] [illegible]Priem (1997), p. 40[illegible]

[13] [illegible]Ward & Brownlee (2004), p. 49[illegible]

[14] Morrison, Morrison & The O.ce of Charles and Ray Eames (1994), p. 7.

[15] □□□Gleick (1988) and Peterson (1995)□

[16] Kasting, Whitmire & Reynolds (1993), p. 108. [illegible]“[illegible]”[illegible]“[illegible]”□□□

[17] Ward & Brownlee (2004), pp. 15..

[18] □□□Westbroek (1992 & 2009)□

[19] □□□McSween (1997), p. 119□May, Moore & Lintott (2006), p. 108□

[20] Reeves (1991), pp. 73-74.

[21] □□□Budyko (1986) and Smil (2006), pp. 22.□

[22] □□Cloud (1988), p. 123□

[23] □□Strangway (1970)□

[24] □□□van Andel (1994), pp. 90-94□

[25] Van Andel (1994), p. 126.

[26] [illegible]2005[illegible]40%[illegible]

[27] [illegible]White (1959), pp. 34.[illegible]·□□□ (E. Broda□1975)[illegible]·□□□ (Ronald Fox□1988)[illegible]

[28] [illegible]Hamilton (2008)□

[29] [illegible]·[illegible]Konrad Lorentz[illegible]“[illegible]”□□□Chaisson (2001), p. 176[illegible]Lehninger (1975), pp. 3-4[illegible]·[illegible]What is Life?, 1944[illegible]2013[illegible]

[30] Jantsch (1983), pp. 102-103.

[31] See, for instance, Smil (2006), p. 24.

[32] Chaisson (2006), p. 318-319.

[33] [illegible]Encyclopedia of Science□(www.daviddarling.info/encyclopedia/D/DarwinC.html)□“[illegible]·□□□Joseph Hooker□1871[illegible]‘[illegible]’[illegible]‘[illegible]’”□

[34] □□□Pleij (1995); Whit.eld (2004); and Koonin & Martin (2005)□

[35] Chaisson (2001), pp. 169-170.

[36] Niele (2005), p. 8.

[37] Koonin & Martin (2005), Cairns-Smith (1995).

[38] [illegible]Belderok (2008)[illegible]Glasby (2006)[illegible]Titan[illegible]

[illegible]

[illegible]

[illegible]

[illegible]40[illegible][1]

[illegible]

[illegible]5.4[illegible]

[illegible][2]

[illegible]35[illegible]20[illegible]15[illegible]5.4[illegible][3][illegible]

[illegible]“[illegible]”[illegible]“[illegible]”[illegible]

[illegible]

[illegible]“[illegible]”[illegible]complex adaptive systems[illegible]·[illegible]Murray Gell-Mann[illegible][4][illegible]

[illegible]positive feedback[illegible]genetic learning[illegible]“[illegible]”[illegible]

[illegible]host cells[illegible]

[illegible]

[illegible]

[illegible][5]

[illegible][6][illegible]Azotobacter[illegible]10,000[illegible]/[illegible]2[illegible]/[illegible]20[illegible]

[illegible]

[illegible]

[illegible]19[illegible][7]

[illegible]·[illegible]Anastassia Makarieva[illegible]2008[illegible]3000[illegible]4[illegible]20[illegible]1[illegible]/[illegible]4[illegible]/[illegible]1~4[illegible]/[illegible][8][illegible]2[illegible]/[illegible]

[illegible][9][illegible]

[illegible]·[illegible]Joseph Tainter[illegible]high-gain energy[illegible]low-gain energy[illegible]

[illegible][10]

[illegible]——[illegible]——[illegible]

[illegible]（bauplāne）[illegible]（general structural regimes）[illegible]

[illegible]“[illegible]”[illegible]“[illegible]”（niches）[illegible]“[illegible]”（biome）[illegible]

[illegible]·[illegible]·[illegible][11][illegible]

[illegible]

[illegible][12][illegible]——[illegible]——[illegible]

[illegible]4[illegible]

[illegible]

[illegible]

[illegible]

[illegible]·[illegible] 1991[illegible]136[illegible]“[illegible]”[illegible]

[illegible]40[illegible]10%[illegible]25%[illegible]

[illegible]

[illegible]·[illegible]（Thomas Graedel）[illegible]·[illegible]（Paul Crutzen）[illegible][13]

[illegible]38[illegible] 16[illegible]26[illegible]13[illegible]13[illegible]

[illegible][14][illegible]



[illegible]

[illegible]45[illegible]——[illegible]60×10^{-4}[illegible]/[illegible]——[illegible]

[illegible]

[illegible]20[illegible]·[illegible]·[illegible]Vladimir Ivanovich Vernadsky[illegible]1863—1945[illegible]“[illegible]”[illegible]biosphere[illegible]·[illegible]Eduard Suess[illegible]1831—1914[illegible]20[illegible]80[illegible]“[illegible]”[illegible]System Earth[illegible][15]

[illegible]20[illegible]5.4[illegible]4[illegible]“[illegible]”[illegible]microbial mats[illegible]

20[illegible]80[illegible]·[illegible]James Lovelock[illegible]1919—[illegible]30[illegible]25%[illegible]“[illegible]”[illegible]

[illegible]

[illegible]——[illegible]——[illegible]

[illegible]

[illegible]20[illegible]

[illegible]45[illegible]25%[illegible][16]

[illegible]

[illegible]2006[illegible]·[illegible]·[illegible]Victor Gorshkov[illegible]biotic pump theory[illegible]“[illegible]”[illegible]·[illegible]Alexander Markow[illegible]2009[illegible]

[illegible]·[illegible]David Raup[illegible]99%[illegible][17][illegible]

[illegible]

[illegible]“[illegible]”[illegible]“[illegible]”[illegible][18][illegible]

[illegible]microclimates[illegible]——[illegible]——[illegible]

[illegible]

[illegible]“[illegible]”（prokaryotes）[illegible]（stromatolites）[illegible]34[illegible]（Shark Bay）[illegible]

[illegible]（cyanobacteria）[illegible]“[illegible]”[illegible]“[illegible]”（photosynthesis）[illegible]34[illegible]·[illegible]“[illegible]”（phototrophic regime）[illegible][19]

[illegible]

[illegible]“[illegible]”（speciation event）[illegible]（adaptive radiation）[illegible]·[illegible]·[illegible]（John de Vos）[illegible][20][illegible]

[illegible]

[illegible]20[illegible]

[illegible]biomass[illegible]energy deposits[illegible]“[illegible]”[illegible]Proterozoic oil deposits[illegible]25[illegible]5.5[illegible]——[illegible]13[illegible]——[illegible][21]

[illegible]aerobic respiration[illegible]anaerobic respiration[illegible]16[illegible]

[illegible]20[illegible]“[illegible]”[illegible]mitochondria[illegible]“[illegible]”[illegible]chloroplasts[illegible]

[illegible]

[illegible]6[illegible][22]

[illegible]

[illegible]5.75[illegible]5.4[illegible][23]

[illegible]

[illegible]

[illegible]path dependency[illegible]electromagnetism[illegible]

[illegible]

[illegible]genomes[illegible]DNA[illegible]

[illegible]“[illegible]”[illegible]Ediacaran[illegible]

[illegible]5.65[illegible]5.42[illegible]

[illegible]5.4[illegible]“[illegible]”[illegible]Cambrian explosion of life forms[illegible]“[illegible]”[illegible][24]

[illegible]selective pressure[illegible]4[illegible]Pikaia gracilens[illegible]chordate[illegible]vertebrates[illegible]

[illegible]——[illegible]——[illegible]

[illegible]

[illegible]

[illegible]0.09[illegible]/[illegible]

[illegible]——[illegible]——[illegible]

[illegible]——[illegible]——[illegible]

[illegible]

[illegible]

[illegible]2[illegible]/[illegible]0.09[illegible]/[illegible]

[illegible]sedimentation[illegible]

[illegible]

[illegible]
[illegible]

[illegible]

[illegible]6,000[illegible]“[illegible]”[illegible]Snowball Earth[illegible][25]

[illegible]·[illegible]·[illegible][26]

> [illegible]2,700~2,300 Myr[illegible]1Myr =[illegible]BP[illegible]
>
> [illegible]1,000 Myr[illegible]950Myr[illegible]820~730Myr[illegible]640~580Myr[illegible]

[illegible]30[illegible]20[illegible][27]

2005[illegible]·[illegible]Alex Pavlov[illegible][28][illegible]

2.3 [illegible] 8 [illegible] 3 [illegible]

[illegible] —— [illegible] —— [illegible]

[illegible] “[illegible]” [illegible] “[illegible]” [illegible][29]

[illegible]

[illegible]

[illegible][30]1986[illegible]·[illegible]2005[illegible]·[illegible]·[illegible][31][illegible]1980[illegible]·[illegible]Daniel Koshland, Jr.[illegible][32]

[illegible]

[illegible][33][illegible]

——2013lateral habenula“”[34]

gutfeeling“”

[illegible]

[illegible][35]

[illegible]90%[illegible]

[illegible]

[illegible][36][illegible]“[illegible]”[illegible]Rodinia[illegible]“[illegible]”[illegible]11[illegible]7.5[illegible]6[illegible]5.4[illegible]“[illegible]”[illegible]Pannotia[illegible]“[illegible]”[illegible]“[illegible]”[illegible]Pangea[illegible]“[illegible]”[illegible]2.5[illegible]1.7[illegible]

[illegible]genera[illegible]

[illegible]

[illegible]

[illegible]

[illegible]4[illegible]4[illegible]

[illegible]·[illegible]James Gould[illegible]·[illegible]William Keeton[illegible][37]

> [illegible]——[illegible]fixed nitrogen[illegible]——[illegible]——[illegible]

[illegible]“[illegible]”[illegible]

[illegible]——[illegible]——[illegible]

[illegible]“[illegible]”[illegible]landlubbers[illegible]

[illegible]

[illegible]4[illegible]Carboniferous[illegible]Permian[illegible]3.6[illegible]2.48[illegible]35%[illegible]1.5[illegible]21%[illegible][38]

[illegible]Devonian[illegible]4.08[illegible]2.9[illegible]2.9[illegible]2.48[illegible]——[illegible][39][illegible]1.5[illegible][40]

[illegible]

[illegible]3[illegible]

[illegible]

[illegible]·[illegible]“[illegible]”（social plants）[41][illegible]“[illegible]”[illegible]

[illegible]

[illegible]（large browsers）[illegible]

[illegible]

[illegible]2[illegible]——[illegible]——[illegible][42][illegible]——[illegible]——[illegible]

[illegible]20,000[illegible]6,500[illegible]“[illegible]”（nuclear winter）[illegible]“[illegible]”（Deccan Traps）[illegible]Yucatán[illegible][43]

[illegible]

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[1] [illegible]

[2] [illegible]·[illegible]Engelbert Broda[illegible]1975[illegible]·[illegible]Ronald Fox[illegible]1988[illegible]·[illegible]2005[illegible]·[illegible]

[3] 2007[illegible]·[illegible]5,500[illegible]Markow & Korotayev (2007)[illegible]

[4] [illegible]“[illegible]”[illegible]Gell-Mann (1994), pp. 16.[illegible]

[5] David Christian (2003)[illegible]

[6] Broda (1975), p. 41.

[7] [illegible]Westerho., Hellingwerf & van Dam (1983)[illegible]Rutgers, van der Gulden & van Dam (1989)[illegible]·[illegible]J.rg Stucki[illegible]1980[illegible]

[8] Makarieva, Gorshkov, Li, Chown, Reich & Gavrilov (2008).

[9] [illegible]

[10] Tainter, Allen, Little & Hoekstra (2003). [illegible]Allen, Tainter & Hoekstra (2003)[illegible]

[11] [illegible]·[illegible]·[illegible]

[12] [illegible]Chaisson (2001), p. 32[illegible]

[13] Graedel & Crutzen (1993), pp. 32-33.

[14] Ward & Brownlee (2004), p. 201.

[15] [illegible]Vernadsky (1998); Carroll (2000); and Priem (1993)[illegible]

[16] □□ □□□□□□□Allègre & Scheider (2000), p. 222)□□□□□□□□□□□□□□□□□□□□□□□ □□□ (2000, p. 128), □Kasting, Whitmire & Reynolds (1993, pp. 118-119)□□□□□ □□

[17] □□Lovelock (1987 & 2000), p. 96□Raup (1993)□

[18] □□Lovelock (2000 & 2006)□

[19] Niele (2005), p. 11.

[20] De Vos (2004).

[21] □□□□□□□□□□□□□□University of California Museum of Paleontology website□□www.ucmp.berkeley.edu/bacteria/cyanofr.html.

[22] □□□·□□□Nick Lane□□□□□□□2009□□□□□□□□□□□□□□□□□□

[23] 2009□□□□□□□□□□□□□□8.5□□□□□□□□□□□□□□□□□□□□□□□□□□□□ □□□Fox (2009)□

[24] □□□Gould & Eldredge (1989); Conway Morris (1998); O’Donoghue (2007a)□

[25] □□□Walker (2003)□

[26] Graedel & Crutzen (1993), p. 194.

[27] □□Perkins (2009)□

[28] □□Pavlov, Toon, Pavlov, Bally & Pollard (2005)□Reich (2005)□

[29] □□“□□□□□□”□“□□□□□□”□□□□□□□□□□□·□□□Jan Romein□1937□□□□

[30] □□□□□□□□□□□□□□□□Allman (1999)□

[31] Reeves (1986), pp. 184-186, Karel van Dam (2007), □□□□□□□□□□□□□ □□□□□□□□□□□□□□□□□□□□·□□□□David Mindell□□□□□ (2008)□

[32] Koshland (1980), p. 2 and p. 144.

[33] 1980□□□□□·□□□□□□□□□□□□□□□□·□□□□□·□·□□□□□□□□□□□□145□□□ □□□□□□□□□

[34] Gershon (1998), Stopper & Floresco (2013).

[35] □□□□□□□□□□□□□□□□□□□□□□□□□□□□□Wicander & Monroe (1993) and Gould & Keeton (1996)□

[36] Tuzo Wilson, □□□Wicander & Monroe (1993), p. 194□

[37] Gould & Keeton (1996), p. 612.

[38] Pyne (2001), p. 7.

[39] □□Potts (1996), p. 21□□□□□□□□□□O’Donoghue (2007b)□

[40] Osborne & Tarling (1995), p. 104.

[41] Von Humboldt (1997), pp. 346.., and Darwin (1985), p. 135.

[42] Wicander & Monroe (1993), p. 449.

[43] 1992□□□□·□□□□□□Curt Wiederhielm□□□□□□□□□□□□□□□□“□□□□”□□□□□□□□□□□□□□□·□□□David Weber□□□□□□□□□□□□□□□□□□□□□□□Theory for the origin of the Deccan traps□2008□□□

[illegible]

[illegible]

[illegible]

[illegible]“[illegible]”[illegible]6000[illegible]5000[illegible]“[illegible]”[illegible]prehistory[illegible]——[illegible]400[illegible]——[illegible]1[illegible][1]

[illegible]——[illegible]——[illegible]——[illegible]

[illegible]“[illegible]”[illegible]culture[illegible]

[illegible]

[illegible]3[illegible]

[illegible][2]

[illegible]15[illegible]/[illegible]2[illegible]/[illegible][3][illegible]·[illegible]Pierre Magistretti[illegible]·[illegible]Luc Pellerin[illegible]-[illegible]·[illegible]Jean-Luc Martin[illegible][4]

> [illegible]2%[illegible]15%[illegible]20%[illegible]25%[illegible]57[illegible]100[illegible]50%[illegible]10%[illegible]

[illegible]

[illegible]

[illegible]2004[illegible]·[illegible]“[illegible]”[illegible]collective learning[illegible]

[illegible]“[illegible]”[illegible]cultural learning[illegible][5]

[illegible]“[illegible]”[illegible]“[illegible]”[illegible][6][illegible]

[illegible]genetic disinformation[illegible]symbolic disinformation[illegible]

[illegible]“[illegible]”[illegible]cultural forgetting[illegible]

[illegible]1986[illegible]·[illegible][7]

> [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]“[illegible]”（niche construction）[illegible][8][illegible]

[illegible]150[illegible]50[illegible]5[illegible]1[illegible]（muscle power）[illegible]250[illegible]

[illegible]

[illegible]2~5[illegible]/[illegible]2[illegible]/[illegible]5[illegible]/[illegible]

[illegible]

[illegible][9][illegible]M. [illegible]·[illegible]（M. King Hubbert）1956[illegible]

1970[illegible]——[illegible]——[illegible][10]

[illegible]——[illegible]——[illegible]

[illegible][11]

[illegible]

[illegible]

[illegible]600[illegible]400[illegible]400[illegible]200[illegible]200[illegible]

[illegible]700[illegible]600[illegible]400[illegible]20~30[illegible]900[illegible]I. G.[illegible]I. G. Simmons[illegible][12]

[illegible]

[illegible]2[illegible]/[illegible][13]

[illegible]

[illegible]400[illegible]200[illegible]

[illegible]“[illegible]”[illegible]Australopithecus[illegible]
[14]

[illegible]5500[illegible]Eocene period[illegible][15]

[illegible]

[illegible]Rift[illegible]Zambezi[illegible]

[illegible]·[illegible]Adriaan Kortlandt[illegible]1918—2009[illegible]chimpanzees[illegible]Australopithecines[illegible]
[16]

[illegible]200[illegible]

[illegible][17]

[illegible]

[illegible]1995[illegible]·[illegible]*Keeping Together in Time*[illegible]——[illegible]——[illegible]primates[illegible]

[illegible]·[illegible][18][illegible]

[illegible]400[illegible]200[illegible]200[illegible]

[illegible]

[illegible][19]

[illegible]

[illegible]

[illegible]——[illegible]——[illegible]

[illegible]250[illegible]

[illegible]opposable thumb[illegible]

[illegible][20][illegible]

[illegible]190[illegible]50[illegible]Homo erectus[illegible]

[illegible]250[illegible]

[illegible]·[illegible]Rick Potts[illegible][21]

> [illegible]
>
> [illegible]

[illegible][22]

> [illegible]……[illegible]……[illegible]

[illegible]

[illegible]1918[illegible]·[illegible]（Louis Bolk，1866—1930）[illegible]“[illegible]”（neoteny）[illegible]——[illegible]——[illegible][23]

[illegible]

[illegible]20%[illegible]

[illegible]

[illegible]

[illegible]·[illegible]Leslie Aiello[illegible]1946—[illegible]·[illegible]Peter Wheeler[illegible]1956—[illegible][24][illegible]

[illegible]11.2[illegible]/[illegible]12.2[illegible]/[illegible][25][illegible]

[illegible]

[illegible]——[illegible]——[illegible]

[illegible]200[illegible]

[illegible]——[illegible]

自己去进行中央集权化——而英国有六七百年是由一个议会统治着的。[26]

[illegible]

[illegible]·[illegible][27][illegible]79[illegible]150[illegible]100[illegible][28]

[illegible]·[illegible]Stephen Pyne[illegible]1949— [illegible][29]

> [illegible]

[illegible]·[illegible]“[illegible]”[illegible]pyrocultural energy regime[illegible][30]

[illegible][31][illegible]

[illegible]

[illegible]

[illegible]·[illegible][32]

[illegible]“[illegible]”[illegible]energy use per capita[illegible]

[illegible]·[illegible]1997[illegible]1~2[illegible][33][illegible]

[illegible]·[illegible][34]

2007[illegible]·[illegible]

[illegible]——[illegible]——[illegible]

[illegible]

[illegible][35][illegible]180[illegible]40[illegible]50[illegible]150[illegible]·[illegible]·[illegible][36]

[illegible]118[illegible]118[illegible][37][illegible]

[illegible]“[illegible]”[illegible][38][illegible]

[illegible]·[illegible]James Trefil[illegible]1938— [illegible]·[illegible]John Barrow[illegible]1952— [illegible]6.1[illegible]·[illegible]——[illegible]——[illegible][39]

[illegible][40][illegible]

[illegible]

[illegible]·[illegible]Brian Fagan[illegible]1936— [illegible]·[illegible]Andrew Sherratt[illegible]1946—2006[illegible]“[illegible]”[illegible]Sahara pump[illegible][41][illegible]“[illegible]Levant[illegible]”[illegible][42]



[illegible]6.1 1995[illegible]1996[illegible]Westerpark[illegible]

[illegible]180[illegible]cultural change[illegible]

[illegible]50[illegible]

[illegible]

[illegible]

[illegible]20[illegible][43][illegible]——[illegible]·[illegible]·[illegible][44][illegible]

[illegible]13[illegible]Skhul[illegible]Qafzeh[illegible]——[illegible]——[illegible]·[illegible]·[illegible]——[illegible]Luigi Luca Cavalli-Sforza[illegible][45][illegible]

[illegible]8[illegible]6[illegible][46][illegible]“[illegible]”[illegible]evolutionary bottleneck[illegible]1[illegible]population implosion[illegible]Toba[illegible][47][illegible]

[illegible]600[illegible]

5 [48] 120

Neanderthals Homo heidelbergensis 4.5 4

3.9 “ ” genocide 4% Denisova Cave DNA DNA 6% 40 Atapuerca 3

4

[illegible]

[illegible]3[illegible]1[illegible]I. G.[illegible]I. G. Simmons[illegible]1937— [illegible]26[illegible]250[illegible][49][illegible]——[illegible]——[illegible]

[illegible]25[illegible]50[illegible]500[illegible]“[illegible]175[illegible]15%~20%[illegible]”[50][illegible]

[illegible][51]

[illegible][52][illegible]

[illegible][53][illegible]2007[illegible]12,900[illegible]Clovis culture[illegible]12,800[illegible]11,500[illegible]“[illegible]”[illegible]Younger Dryas[illegible]·[illegible]James Kennett[illegible]“[illegible]”[illegible][54][illegible]

[illegible]

[illegible]“[illegible]”[illegible]·[illegible]Robert Wenke[illegible][55]

[illegible]“[illegible]”[illegible]Rorschach test[illegible]

[illegible]“[illegible]”[illegible]“[illegible]”[illegible]shamans[illegible]

[illegible]8,000[illegible]“[illegible]”[illegible]religious needs[illegible][56][illegible]——[illegible]——[illegible]

[illegible]“[illegible]”[illegible]religious constraints[illegible][57][illegible]400[illegible]1[illegible]

□□□□□□□□□□□600□□□

□□□□

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[1] [illegible]

[2] [illegible]Tre.l (1997)[illegible]Allman (1999)[illegible]

[3] Chaisson (2001), p. 139.

[4] Magistretti, Pellerin & Martin (2000).

[5] Christian (2004)[illegible]·[illegible]·[illegible] (1995, p. 80)[illegible]1960[illegible]·[illegible]·[illegible]·[illegible]Lyon Sprague de Camp[illegible] (1993, p. 17)[illegible]

[6] [illegible]Potts (1996), pp. 181.[illegible]

[7] McNeill (1986), pp. 6-7.

[8] [illegible]Odling-Smee, Laland & Feldman (2003)[illegible]·[illegible]1881[illegible]

[9] [illegible]White (1943 & 1959); Harris (1975, 1980 & 1997); Elias (1978); McNeill (1963 & 1991), pp. vii-xiii; Smil (1994); McNeill & McNeill (2003); Christian (2004); and Crosby (2006)[illegible]

[10] [illegible]Cook (1976), p. xii[illegible]

[11] [illegible]Smith (2000)[illegible]

[12] Simmons (1994), p. 30.

[13] Cook (1971), p. 136[illegible] /[illegible] /[illegible] /[illegible]40[illegible] /[illegible]

[14] [illegible]·[illegible]1871[illegible]Darwin (2004), pp. 72-73[illegible]van Andel (1994), pp. 90-94; Gamble (1995), pp. 79-84; Tudge (1993 & 1996); Vrba (1993) and Vrba, Denton, Partridge & Burckle (1995). Thorpe, Holder & Crompton (2007)[illegible]

[15] [illegible]Potts (1996), pp. 50.[illegible]

[16] Kortlandt (1972); [illegible]Coppens (1994) and Kortlandt vs. Coppens (1994)[illegible]

[17] [illegible]Potts (1996)[illegible]

[18] Kortlandt (1980).

[19] [illegible]Goudsblom (1990 & 1992) and Gamble (1995), pp. 66-70[illegible]

[20] □□□□□□□□·□□□□□Anton Pannekoek□1953□□Pannekoek (1909)□

[21] Potts (1996), pp. 11-12.

[22] Potts (1996), p. 121.

[23] 1918□□□□□□□□□□□□□·□□□□□□□□□□□□□□□□□□□□□□□□“□□□□”□□□□□□□□□□□□□□□□□ (1918 & 1926)□□□□□□Gould & Eldredge (1977), pp. 63-69, and (1993), and Vélez (1998, 2007, 2013)□

[24] Aiello & Wheeler (1995), pp. 199-221. See also Roebroeks (2007).

[25] □□□□□□□□“□□□□□”□mass-speci.c metabolic rate□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□15□ /□□□□□□□□□□□□□□□□□□

[26] Gershon (1998).

[27] Darwin (2004), p. 68.

[28] □□□□□□□□□□□□□□□□□□□□□□□□□□□□Alperson-A.l (2008) ; □□□□Goudsblom (1992), pp. 16.., and Simmons (1994), pp. 38-39□

[29] Pyne (2001), p. 30.

[30] Niele (2005), pp. 29..

[31] □□□Gamble (1995), pp. 66-70; Goudsblom (1992); and Pyne (2001)□

[32] Goudsblom (1992), pp. 20..

[33] Reijnders (2006).

[34] Pyne (2001), pp. 24..

[35] □□□Gamble (1995); Simmons (1994), pp. 38-42; and Williams, Dunkerley, DeDeckker, Kershaw & Stokes (1993), pp. 190-221□

[36] □□□McNeill (1963) and Harris (1975), pp. 164.□

[37] Reed, Smith, Hammond, Rogers & Clayton (2004)□□□□□□□□□□□□□□□□□□□□□□

[38] □□□Smith (2007)□

[39] Tre.l (1994), p. 11, and Barrow (1995), pp. 91..

[40] McNeill (1976), pp.15-33.

[41] Sherratt (1996 & 1997).

[42] Sherratt (1996), p. 133.

[43] □□□Potts (1996) and McBrearty & Brooks (2000)□

[44] De Vos (2004).

[45] Cavalli-Sforza (2000), pp. 93..

[46] □□Mellars (2006); Burroughs (2006), pp. 109..; and Jones (2007)□

[47] Zeilinga de Boer & Sanders (2002), pp. 155-156.

[48] [illegible]Fladmark (1979) and Gruhn (1988)[illegible]Pringle (2007b) and Dillehay (1997)[illegible]

[49] Simmons (1994), p. 43.

[50] Simmons (1994), p. 44.

[51] [illegible]Pyne (2001)[illegible]

[52] [illegible]Simmons (1994), p. 37 and pp.74-75[illegible]

[53] [illegible]Zeilinga de Boer & Sanders (2002 & 2005) and Fagan (2004)[illegible]

[54] Pringle (2007a); Firestone, West, Kennett et al. (2007); and Kennett, Kennett, West et al. (2009)[illegible]van der Hammen & van Geel (2008)[illegible]

[55] Wenke & Olszewski (2007), p. 172.

[56] Spier (1994).

[57] [illegible]Spier (1994, 1996)[illegible]Bellah (2011)[illegible]

——11—12

System of Nature 2001 p. 11 1770 p. 3

[illegible]

[illegible]“[illegible]”[illegible]1[illegible]dominant adaptive mechanism[illegible]1[illegible]——[illegible]100[illegible]——[illegible]70[illegible]1800[illegible]Anthropocene[illegible][1]

[illegible]1[illegible]biological change[illegible]1[illegible][2]

[illegible]5[illegible]

[illegible]·[illegible]1991[illegible]pp. 75-76[illegible]

[illegible]“[illegible]”[illegible]——[illegible]——[illegible]……[illegible]

[illegible]

[illegible]——[illegible]——[illegible]

[illegible]——[illegible]——[illegible]“[illegible]”[illegible]

[illegible]

[illegible]20[illegible]

[illegible]“[illegible]”[illegible]——[illegible]“[illegible]”[illegible]——[illegible]

[illegible]“[illegible]”[illegible]“[illegible]”[illegible]

[illegible][3][illegible][4]

[illegible]·[illegible]·[illegible]Gaius Julius Caesar[illegible]100—[illegible]44[illegible][5][illegible][6]

[illegible]53[illegible]Vercingetorix[illegible]Alesia[illegible]100[illegible]100[illegible]1/3[illegible]

[illegible]

[illegible]1[illegible]·[illegible]2003[illegible]·[illegible][7]

[illegible]

[illegible]·[illegible]

[illegible]·[illegible]“[illegible]”[illegible]1963[illegible]*The Shape of European History*,1974[illegible]·[illegible]Jerry Bentley[illegible]1949—2012[illegible]

20[illegible]80[illegible]·[illegible]·[illegible]Immanuel Wallerstein[illegible]1930— [illegible]·[illegible]·[illegible]Andre Gunder Frank[illegible]1929—2005[illegible]“[illegible]”[illegible]1991[illegible]·[illegible]John R. McNeill[illegible]1954— [illegible]2003[illegible]

[illegible]20[illegible]1[illegible]

[illegible]

[illegible]1[illegible]100[illegible]1,000[illegible]

[illegible]

[illegible]·[illegible]“[illegible]”[illegible]agrocultural energy regime[illegible][8][illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]·[illegible]Stephen Budiansky，1957— [illegible][9][illegible]

[illegible]·[illegible]·[illegible]·[illegible]“[illegible]”[illegible]

[illegible]“[illegible]”[illegible]

[illegible]



[illegible]7.1 [illegible]1986[illegible]1[illegible]Zurite[illegible]Cconucuyca[illegible]

[illegible][10][illegible][11][illegible][12]

[illegible]“[illegible]”[illegible]Holocene[illegible]13,500[illegible]12,900[illegible]11,700[illegible]“[illegible]”[illegible]2007[illegible]12,900[illegible][13]

[illegible]125,000[illegible][14][illegible]

[illegible]·[illegible]Bruce Smith[illegible]1946— [illegible][15]

> [illegible]

[illegible]·[illegible]David Harris[illegible]1930— [illegible][16][illegible]

[illegible]

[illegible]Fertile Crescent[illegible]

[illegible][17]

[illegible]·[illegible]Abu Hureyra[illegible]1.3[illegible]

[illegible]·[illegible]William Burroughs[illegible]1942—2007[illegible][18]

[illegible]·[illegible]4[illegible]·[illegible]Gordon Hillman[illegible]……[illegible]

[illegible]

[illegible]·[illegible]2009[illegible]3,200[illegible]800[illegible]500[illegible]

[illegible]

[illegible]

traction plow

——

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1818·[illegible]·

……

……

·[illegible]··Aimé Bonpland1799—1804 *Personal Narrative of Travels to the Equinoctial Regions of the New Continent, During the Years 1799—1804* Vol. III London: Longman, Hurst, Rees, Orme,and Brown, 181814—15

[illegible]

[illegible]

[illegible]6,500[illegible][19][illegible]draft animals[illegible]——[illegible]——[illegible]foot plows[illegible]

[illegible]——[illegible]polygamy[illegible]——[illegible]——[illegible]

[illegible]

[illegible]·[illegible]Alfred Crosby[illegible]1931— [illegible]·[illegible]Jared Diamond[illegible]1937— [illegible]1.7[illegible]

[illegible]

[illegible]unbeatable head start[illegible][20]

[illegible]1,500[illegible]·[illegible]Neil Roberts[illegible]3,500[illegible]1,500[illegible][21][illegible]200[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible] 100 [illegible] 1,000 [illegible] 5,000 [illegible] 500 [illegible] 2,000 [illegible][22]

[illegible]·[illegible] Eric Wolf [illegible] 1923—1999 [illegible][23] [illegible] “[illegible]”（social cages）[illegible][24] [illegible] “[illegible]”（chiefdoms）[illegible]

[illegible]

[illegible]

[illegible]·[illegible][25]

[illegible]

[illegible][26][illegible]“[illegible]”[illegible][27]

[illegible]8,000[illegible]20[illegible]

[illegible]

[illegible]——[illegible]Pleiades[illegible]——[illegible][28]

[illegible]

[illegible]·[illegible]priest-chiefs[illegible]“[illegible]”[illegible]“[illegible]”[illegible][29]

[illegible]

[illegible]·[illegible]·[illegible]

[illegible][30]

[illegible]“[illegible]”[illegible]supernatural nature[illegible][31][illegible]Earth mother[illegible][32][illegible]

[illegible]Göbekli Tepe[illegible]11,500[illegible]——[illegible]

[illegible]

[illegible][33][illegible][34][illegible]

[illegible]“[illegible]”[illegible]age of the teacup[illegible][35]

[illegible][36][illegible]

[illegible]

[illegible][37][illegible]

[illegible][38][illegible]

[illegible][39]

[illegible]

[illegible]·[illegible]·[illegible]（Earl Ferguson Cook，1920—1983）[illegible]1971[illegible]J. G.[illegible]·[illegible]（John Bennett）[illegible][40]

[illegible]120[illegible]80[illegible]“[illegible]”[illegible]160[illegible]“[illegible]”[illegible]320[illegible]“[illegible]”[illegible]240[illegible]480[illegible]“[illegible]”[illegible]280[illegible]“[illegible]”[illegible]40[illegible]“[illegible]”[illegible]

[illegible]“[illegible]”[illegible]

[illegible]·[illegible]

[illegible]·[illegible]Norbert Elias[illegible]1897—1990[illegible]“[illegible]”[illegible]figurations[illegible]

[illegible]

[illegible]*The Cirilizing Process*[illegible]1939[illegible]1000[illegible]1643—1715[illegible]

[illegible]“[illegible]”[illegible]civilizing process[illegible]

[illegible]

[illegible]“[illegible]”[illegible]1689[illegible]Speyer[illegible]Worms[illegible]

[illegible]

[illegible]

[illegible]

[illegible]6,000[illegible]5,000[illegible]2,500[illegible]5,000[illegible]5,000[illegible]4,500[illegible]4,000[illegible]3,500[illegible]

[illegible]·[illegible]Max Weber[illegible]·[illegible][41]

[illegible]5,000[illegible]

[illegible]“[illegible]”[illegible]rise of civilizations[illegible]10%[illegible]90%[illegible]

[illegible]symbiosis[illegible][42][illegible]

[illegible]

[illegible]

[illegible]

[illegible]“[illegible]”[illegible]·[illegible]Robert Carneiro[illegible]1927— [illegible]1970[illegible]“[illegible]”[illegible]ecologically circumscribed[illegible][43]

[illegible]120[illegible][44][illegible]Holocene optimum[illegible]

[illegible]

[illegible]

[illegible]“[illegible]”（statification[illegible]

[illegible]（ziggurats[illegible]（pyramids[illegible]（huacas[illegible]（Stonehenge[illegible]

[illegible][45][illegible]



[illegible]7.2 [illegible]
[illegible]2011[illegible]

[illegible]

[illegible] 1,000 [illegible] —— [illegible]

[illegible] Chimú [illegible] Huari [illegible]

[illegible]

[illegible] 4,000 [illegible] 500 [illegible] ·[illegible] Brian Fagan [illegible] Yucatán [illegible] [46] [illegible] ·[illegible] Bas van Geel [illegible] 1947— [illegible] 850 [illegible] [47]

[illegible]

[illegible]

[illegible]——[illegible]——[illegible][48][illegible]

[illegible]

[illegible]6,000[illegible]5,000[illegible]

[illegible]·[illegible]Benedict Anderson[illegible]“[illegible]”[illegible][49][illegible]“[illegible]”[illegible]

[illegible]

[illegible]

[illegible]“[illegible]”[illegible]

[illegible]100[illegible]1492[illegible]

[illegible]

[illegible]

18[illegible]*Systeme de la Nature*[illegible]1770[illegible]——[illegible]——[illegible]

[illegible]

[illegible]30[illegible]

[illegible]30[illegible]

[illegible]

[illegible]

[illegible]——[illegible]——[illegible]

[illegible]

[illegible]

[illegible]——[illegible]——[illegible]

[illegible]

[illegible]2003[illegible][50][illegible]

[illegible]

[illegible]·[illegible]——[illegible]——[illegible]

[illegible][51][illegible]·[illegible]

[illegible]·[illegible]·[illegible]·[illegible]（Lyon Sprague de Camp，1907—2000）[illegible]*The Ancient Engineers*[illegible][52]

[illegible]

[illegible]

[illegible]·[illegible]——[illegible]

[illegible]“[illegible]”（architecture of power）[illegible]6,000[illegible]5,000[illegible]10[illegible]137[illegible]10[illegible]

2003[illegible]·[illegible]（Joseph Tainter，1949— ）[illegible]

Etruscans

·1974 1000

moldboard plow

—— ——2000

· “ ”

· Lewis Mumford 1895—1990 *The City in History* [53]

· William Rathje 1945—2012 · Cullen Murphy 1952— [54]

C.W. Blegen 20 50 “ ” “ ” “ ” tells

1973 [illegible] · [illegible] Charles Gunnerson [illegible] 1920—2005 [illegible] [55] [illegible]

[illegible] [56] [illegible]

[illegible] · [illegible] [57]

[illegible]

[illegible]

[illegible] · [illegible] “[illegible]” [illegible] carbo-cultural energy regime [illegible] [58] [illegible]

[illegible] [59] [illegible]

[illegible]

[illegible]500[illegible]500[illegible]5[illegible]

[illegible]Seven Seas[illegible]100[illegible]

[illegible][60][illegible][61]

[illegible]15[illegible]1453[illegible]1430[illegible]Basque[illegible]

[illegible]16[illegible]

[illegible][62][illegible]

—— ——

· Dennis Flynn 1945— · Arturo Giráldez 1952—

15 1570

1545 1548 1571

19 1803 [63]

1580 · “ ” Columbian exchange · Wolf Schäfer 1942— [64]

· *Plagues and Peoples,* 1976

[illegible]19[illegible]“[illegible]”[illegible]

[illegible]17[illegible]2010[illegible]·[illegible]*Mosquito Empires*[illegible]1776[illegible]

[illegible][65][illegible]1683[illegible]300[illegible]

[illegible][66]

[illegible]

[illegible]·[illegible]“[illegible]”[illegible]quantification of reality[illegible][67][illegible]

[illegible]15[illegible]Admiral Zheng He[illegible]1371—1433[illegible]

[illegible][68]

[illegible]

[illegible]“[illegible]”[illegible]“[illegible]”[illegible]17[illegible]20[illegible]“[illegible]”[illegible]20[illegible]

[illegible][69]

1776—1825[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]·[illegible]·[illegible]——[illegible]·[illegible]·[illegible]Wilhelm von Humboldt[illegible]·[illegible]·[illegible]——[illegible]——[illegible]

[illegible]

18[illegible]19[illegible]

[illegible]peat[illegible]17[illegible]1800[illegible]·[illegible]·[illegible]200[illegible][70][illegible]

[illegible]19[illegible]

[illegible]18[illegible]——[illegible]

[illegible]



□7.3 □□□
1970□□□□

□□□·□□□Thomas Newcomen□1664—1729□□□□□“□□”□□——□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□

18□□70□□□□□□□□·□□James Watt□1736—1819□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□·□□□□□□□□□□□□□□·□□□Matthew Boulton□1728—1809□□[71]□□□□□□□□□□□□□□□□Wedgwood□□□□□□□□□□□□□□□□□□

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Massimo Livi-Bacci 1936— [72]

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1800 9 70

19

[illegible]

[illegible]

[illegible]“[illegible]”（oligopolization）[illegible]

[illegible]“[illegible]”（scientification）[illegible]·[illegible]·[illegible]

[illegible]19[illegible]“[illegible]”[illegible]

[illegible]“[illegible]”[illegible]

[illegible]

[illegible]“[illegible]”[illegible]generation gap[illegible]

[illegible]de-industrialization[illegible]

[illegible]

[illegible]“[illegible]”[illegible]anti-globalization[illegible]

[illegible]

[illegible]70[illegible]——[illegible]70[illegible]——[illegible]

[illegible]19[illegible]1866[illegible]1903[illegible]20[illegible]

[illegible]20[illegible]60[illegible]IBM[illegible]

20[illegible]80[illegible]

[illegible]

[illegible]20[illegible]

[illegible]“[illegible]”[illegible]cultural convergence[illegible]

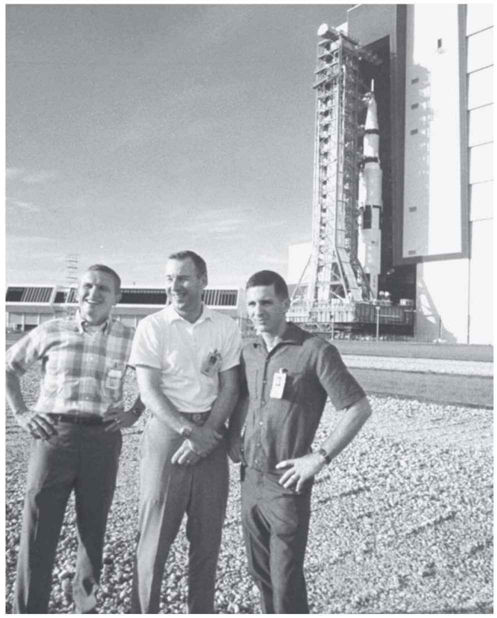
[illegible]

[illegible]privatization[illegible]

[illegible]

[illegible][73]

1961[illegible]7.4[illegible]“[illegible]”[illegible]“[illegible]”[illegible]Spaceship Earth[illegible]·[illegible]



[illegible]7.4 20[illegible]1968[illegible]8[illegible]5[illegible]

[illegible]

[illegible]

2001[illegible]·[illegible]·[illegible]Akop Pogosovitsch Nazaretyan[illegible]1948— [illegible]2010[illegible]2014 ce, pers.com[illegible]

[illegible]……[illegible]ethological balance[illegible]——[illegible]——[illegible]Olduvai Gorge[illegible]*Homo habilis*[illegible]……[illegible]……[illegible]——[illegible]law of techno-humanitarian balance[illegible]

[illegible]

[illegible]2011[illegible]·[illegible]Steven Arthur Pinker[illegible]1954— [illegible]*The Better Angels of Our Nature: Why Violence Has Declined*[illegible]10[illegible]500[illegible]10[illegible]70[illegible]19[illegible]20[illegible]——[illegible]10[illegible]60[illegible]10[illegible]1[illegible]10[illegible]5~10[illegible]

[illegible]·[illegible]Thomas Hobbes[illegible]·[illegible]

[illegible]

[illegible]

[illegible]IEA[illegible]toe per capita[illegible]IEA 2013[illegible]7.1[illegible][74]

[illegible]7.2[illegible]·[illegible]

[illegible]7.1 2011[illegible]

地区	能源使用量（单位：瓦/人均）
世界均值	2,506
孟加拉	279
荷兰	6,185
美国	9,358
卡塔尔	23,727

[illegible]7.2[illegible]

类别	能源使用量（单位：瓦/人均）
狩猎者	200
原始农耕者	480
发达农耕者	1,040
工业时代的人	3,080
拥有技术者	9,200

[illegible]Cook[illegible]1971[illegible]p. 136[illegible]

类别	功率密度值（单位：瓦 / 千克）
恒星	0.0002
植物	0.09
人体	2
人脑	15
传统荷兰风车	0.15
现代德国风车	2
真空吸尘器	180
波音 747 喷气发动机	2,000
航天飞机发动机	2,120,000

[illegible]20[illegible]microclimates[illegible][76]

[illegible]

[illegible]2008[illegible]NASA[illegible]1859[illegible][77][illegible]

[illegible]——[illegible]——[illegible]7,500[illegible][78][illegible]

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[2] [illegible]·[illegible]·[illegible]-[illegible]Luigi Luca Cavalli-Sforza[illegible]1994 & 2000[illegible]·[illegible]Spencer Wells[illegible]5[illegible]1[illegible]·[illegible]Antonio Vélez[illegible]2007, 2013[illegible]1[illegible]Wills[illegible]1999[illegible]Cochran & Harpending[illegible]2009[illegible]

[3] [illegible]·[illegible]·[illegible]Chambers (1994); White (1943, 1959 & 1975); McNeill (1976); Darlington (1969); Tainter (1988); Smil (1994); Lapperre (1997); Diamond (1997); Spier (1992, 1996 & 2005); Allen, Tainter & Hoekstra (2003); McNeill & McNeill (2003); Christian (2004); Crosby (2006); and Burroughs (2006)[illegible]

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[8] Niele (2005), pp. 51..

[9] Budiansky (1992).

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[11] □□□Lewis (1972); Cohen (1977), pp. 21-27; Fiedel (1992), p. 168; Harris (1990, 1996); Reed (1977); and Smith (1995), pp. 16-18□

[12] 1992□□□□□□□□□Spriggs, Wickler□Loy□□□□□□□□□28,000□□□□□□□□□□□□□□□□□□□□□□□□□□□□□·□□□□Gordon Hillman□□□□□□□□·□□□□□Wadi Kubbaniya□□□□□□□18,000□□17,000□□□□□□□□□□□□□□□Dayton (1992), p. 14; Loy, Spriggs & Wickler (1992); and Harris & Hillman (1989)□2009□□Kuijt□Finlayson□□□□□□□□□□□Dhra□□Mueller, Gerardo, Aanen, Six & Schultz (2005)□

[13] Pringle (2007); Firestone, West, Kennett et al. (2007); Kennett, Kennett, West et al. (2009); van der Hammen & van Geel (2008).

[14] □□Gamble in Cunli.e (1994), p. 18□□Wright Jr. in Reed (1977), pp. 281-318□

[15] Smith (1995), p. 211.

[16] Harris (1990).

[17] Piperno & Pearsall (1998).

[18] Burroughs (2006), p. 191 & p. 193. □□□□Hillman, Hedges, Moore, Colledge & Pettitt (2001)□

[19] □□□□□□□□·□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□“□□□□□□”□secondary products revolution□1981□□

[20] Crosby (1972, 1993 & 2006)□1998□□□□□□□□□□·□□□□□□□□□□□□□□□□1997□□□·□□□□Cyril Darlington□□□□□□□□□□□□□The Evolution of Man and Society, 1969□□□□□70—71□□□578—582□□□□□□□□□□□·□□□□□□□□□□□□□□□□□□□□□□·□·□□□□□□□□1997□□□□□294□□□□□□

[21] Roberts (1998), p. 136.

[22] □□□□□□□□□□□□□□2014□3□□□□www.census.gov/population/international/data/worldpop/table_history.php. □□□□□□□□□□□□□□

[23] Wolf (1982), pp. 88..

[24] Mann (1987), pp. 39..

[25] Smith (1995), pp. 211-212.

[26] □□□□□□□□□□□□□□□□□□□□□□Spier (1995)□□□□□□□□□□□□Wolf (1966)□

[27] □□□□□Allen, Tainter & Hoekstra (2003), pp. 61.□

[28] □□□·□□□□□□□□Time: An Essay (1992)□□□□□□□□□□□□□□□□□□□□□□1982□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□

[29] □□□□□□□□□□□□□□□□□□□□Elias (1982), pp. 229-333□

[30] □□□□□□□□□□□□□□□Goudsblom, Jones & Mennell (1996), pp. 70-78; McNeill (1963), pp. 18-22 and pp. 33-40; Elias (1992); and Spier (1994 & 1996)□

[31] □□Spier (1994)□

[32] □□□□□□□□□□□□□□□□□□□□Spier (1995)□

[33] □□

[34] □□Burroughs (2006), pp. 204-207□

[35] □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ (1994 & 1995)□

[36] □□□Rathje & Murphy (1992), pp. 32-33□

[37] □□□Simmons (1994), pp. 14-27□

[38] □□□White (1959), pp. 45-57; Cohen (1977); Redman (1978); Heiser (1990); Budiansky (1992); Fiedel (1992); Simmons (1994); Sanderson (1995); Smith (1995); Mears (2001); Christian (2004); and Bellwood (2005)□

[39] □□McNeill (1976) and Swabe (1998)□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□Hershkovitz, Donoghue, Minnikin et al. (2008)□

[40] Cook (1971), p. 136. □□□□□□□□□□□□□□ /24□□□□□□□□□□□□□□□□□1□ = 4.19□□□□1,000□□ /24□□ = 48.5□□□□□□□□□□□□□□□40□□□□□□□□□□□□□□□□□□3□ /□□□□□□□□□□□2□ /□□□□□□□□□□□□□□□□□□70□□Simmons (1994), p. 24, and Bennett (1976), pp. 42-43□

[41] □□Weber (1997), p. 154, and Elias (1978 & 1982)□

[42] □□McNeill (1976 & 1984) and Crone (1989), pp. 39-40□

[43] Carneiro (1970, 2012). □□□□□□□□□□□□□□□□□□□□□□□□□1844□□□□□·□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ (1994), pp. 300-304□

[44] □□Kennett & Kennett (2006)□

[45] □□□□□□□□□□□□□□□□□□□□□□□□□□Goudsblom in Goudsblom, Jones & Mennell (1996), pp. 70.., and Mann (1987), pp. 45-49□

[46] Fagan (1999, 2000, 2004 & 2008).

[47] □□□Fagan (1999, 2000, 2004 & 2008) and Geel, Bokovenko, Burova et al. (2004)□

[48] □□□□□□□□□□□□□□□□□·□□□Philip Curtin□1984□□□□□□□□□Curtin (1994)□

[49] Anderson (1991).

[50] McNeill & McNeill (2003), p. 7.

[51] McNeill (1976), pp. 6..

[52] Sprague de Camp (1993), p. 372 and p. 13.

[53] Mumford (1961), p. 75.

[54] Rathje & Murphy (1992), pp. 34-35.

[55] Rathje & Murphy (1992), p. 35; Blegen (1963); and Gunnerson (1973).

[56] □□McNeill (1998)□

[57] Sprague de Camp (1993), p. 147.

[58] Niele (2005), pp. 65..

[59] □□□McNeill (1963 & 1984)□

[60] Christian (2004), pp. 389..

[61] □□□□□□□□□□Eisenstein (1993)□□□□□

[62] □□□Sanderson (1995), p. 175□

[63] Flynn & Giráldez (1995, 2002, 2008), von Humboldt (1822).

[64] □□□Crosby (1972 & 1993) and Flynn & Giráldez (1995, 2002 & 2008)□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□Emmer (2003)□□□“□□”(multipliers)□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□

[65] □□□□□□□□Weber (1927), p. 337; Wallerstein (1974, 1980); and Allen, Tainter & Hoekstra (2003), pp. 140.□

[66] Allen, Tainter & Hoekstra (2003), p. 148.

[67] Crosby (1997).

[68] □□□Snow (1988) and Menzies (2002)□

[69] □□□□□□□□□□□□□□□□□□□□□□□□□·□□□Floris Cohen□2010□□□□□

[70] Von Humboldt (1995), pp. 74-75□□□□□□□□□□□□□□□□□□□□□□□□ Bilkadi (1995)□

[71] □□□De Vries (2008); Fieldhouse (1973); Hobsbawm (1968); Landes (1969 & 1998); Pollard (1992); Smil (1994); Stearns (1993); and Wallerstein (1989)□□□1998□4□□□□□□□□□□□□□□□□“□□·□□-□□□□□”□John Muir Paci.c Centuries Conference□□□□□□□□□□□□□□□□□□Kenneth Pomeranz□□□□□□□□□□□□□□□The Great Divergence: Europe, China, and the Making of the Modern World Economy□2000□□□□□□□□□

[72] Livi-Bacci (1992), pp. 100-101.

[73] □□□□□□□□□□□□□□□□□□□□□□·□□□Juan Víctor Nú.ez del Prado□□□□□□□Jenkins (1997)□

[74] International Energy Agency (2013), downloaded from www.iea.org. □□1□□□□toe□□□1□□□1,000□□□□□□□□□□□107□□□41.868□□□□□11,628□□□□□kwh□□□□1□□□□ /□ = 1.33×103□□

[75] □□□□□□□□□□□□□□□□□□60,000□□□15□□□10,000□□□□□□□□□□□□□□NASA□□□

[76] Tre.l (1994)□□□□□□□□□□□□□□□□□□□□

[77] Committee on the Societal and Economic Impacts of Severe Space Weather Events (2008).

[78] □□Trivedi (2007)□□□□□□□□□□□□□□□□□□□□□□Ponting (1992) and McNeill (2000)□

[79] □ □ □ Diamond (1987); Leakey & Lewin (1995); Vitousek, Mooney, Lubchenco & Melillo (1997); and Zalasiewicz (2008)□

[illegible]

[illegible]

[illegible]——[illegible]……[illegible]

——[illegible]·[illegible]Preston Cloud[illegible]
[illegible]*Cosmos, Earth, and Man: A Short History of the Universe*[illegible]1978[illegible]p. 285[illegible]

[illegible]

[illegible]·[illegible]1978[illegible]· [illegible]1987[illegible]·[illegible]1986 &1991[illegible]·[illegible]2004[illegible]·[illegible]2007[illegible]·[illegible]Al Gore[illegible]*The Future,*2013[illegible]

[illegible]

[illegible]·[illegible]Ray Kurzweil[illegible]1948— [illegible]——[illegible]*The Singularity In Near: When Humans Transcend Biology,*2005[illegible]·[illegible]Dmitry Itskov[illegible]1981— [illegible]2045[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]·[illegible]（Donald Rumsfeld，1932— ）[illegible]“[illegible]”（known unknowns）[illegible]

[illegible]“[illegible]”（unknown unknowns）[illegible]17[illegible]——[illegible]

[illegible]

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[illegible]Delphi[illegible]

[illegible]

[illegible]·[illegible]Fred Adams[illegible]1961— [illegible]·[illegible]Greg Laughlin[illegible]1967— [illegible]*The Five Ages of the Universe: Inside the Physics of Eternity*[illegible]big crunch[illegible]

[illegible]“[illegible]”[illegible]cosmological decade[illegible]10^x[illegible]x[illegible]10[illegible]100[illegible]11[illegible]1,000[illegible]138[illegible]

[illegible]“[illegible]”[illegible]14[illegible]14[illegible]50[illegible]20[illegible]50[illegible]Andromeda[illegible]

[illegible]14[illegible]“[illegible]”[illegible]Degenerate Era[illegible]35[illegible]“[illegible]”[illegible]Black Hole Era[illegible]131[illegible]“[illegible]”[illegible]Dark Era[illegible]1,000[illegible]

[illegible] 138 [illegible]

[illegible]

[illegible]

[illegible]20[illegible]50[illegible]50[illegible]30[illegible]

[illegible]20[illegible]

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[illegible]

[illegible]20[illegible]70[illegible]——[illegible]——[illegible]2008[illegible]2009[illegible]“[illegible]”[illegible]Energy for Tomorrow[illegible]·[illegible]David MacKay[illegible]*Sustainable Energy-without the Hot Air*[illegible]

[illegible]“[illegible]”[illegible]1973[illegible][2][illegible]1971[illegible]M.[illegible]·[illegible]M. King Hubbert[illegible]1903—1989[illegible][3]

> [illegible]1[illegible]1,300[illegible]10%[illegible]10%[illegible]300[illegible]

[illegible]·T.[illegible]Howard T. Odum[illegible]1924—2002[illegible][4]

> [illegible]

[illegible]20[illegible]70[illegible]

[illegible]1972[illegible]·[illegible]Dennis Meadows[illegible]1942—[illegible]——[illegible]——[illegible]

[illegible]2020[illegible]2070[illegible]

[illegible]“[illegible]”[illegible]1975[illegible]

[illegible]

[illegible]“[illegible]”[illegible]environmental studies[illegible]WCED[illegible]1987[illegible][5][illegible]Brundtland report[illegible]“[illegible]”[illegible]sustainable development[illegible]“[illegible]”[illegible]

[illegible]NASA[illegible]1975[illegible]·[illegible]James Fletcher[illegible]1919—1991[illegible][6]

[illegible]

[illegible]·[illegible]Graham Turner[illegible]2008[illegible]30[illegible][7][illegible]30[illegible]

[illegible]

[illegible][8] [illegible]

[illegible]1798[illegible]·[illegible]·[illegible]Thomas Robert Malthus[illegible]1766—1834[illegible]*An Essay on the Principle of Population*[illegible]2050[illegible]100[illegible]120[illegible]

[illegible]IEA[illegible]·[illegible]David Strahan[illegible]2008[illegible]8.1[illegible]

[illegible]8.1[illegible]

能源种类	距离枯竭的时间预期
石油（含页岩）	最多 100 年
煤炭	最多 100 年
天然气（包括甲烷气水包合物）	最多 200 年
铀	几十年

“ ” 2011 thorium methane clathrates “ ”

[9]

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15[illegible]terawatt[illegible][10]

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Golden Rule
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reasonable prosperity
·

1991
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158
global brain

[illegible]

[illegible]Proxima Centauri[illegible]4[illegible]——[illegible]——[illegible]1%[illegible]400[illegible]

[illegible]

[illegible]·[illegible]Francis Cucinotta[illegible]2009[illegible]18[illegible]“[illegible]”[illegible]“[illegible]”“[illegible]”[14][illegible]

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[illegible]1959[illegible]·[illegible]·[illegible]Charles Percy Snow[illegible]1905—1980[illegible]“[illegible]”[illegible]*The Two Cultures and the Scientific Revdutio*[illegible]16[illegible]

[illegible]——[illegible]——[illegible]

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[1] □□Raup (1993)□

[2] Broda (1975 & 1978); Cook (1971 & 1976); Debeir, Deléage & Hémery (1991); Fox (1988); and Odum (1971) □□□□□Scientific American Special Issue:'Energy and power.'(1971)□□□□□□□□□□□□□□□□□□□□MacKay (2008); Niele (2005); and Smil (1991, 1994, 1999, 2002, 2003 & 2006)□

[3] Hubbert (1971), p. 61. 1956□□M. □·□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□1965□□1970□□1956□□□□24□□□□"□□□□"□Peak oil□□□1971□□□□□□□□□□□□□□□□□□□□□□□□□2000□□□□□Hubbert□1956□□□22□□2007□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□2004□□

[4] Odum (1971), p. 18.

[5] □□□□□□□□□□□□□World Commission on Environment and Development (1987)□

[6] Cortright (1975).

[7] Turner (2008).

[8] □□Allen, Tainter & Hoekstra (2003)□□□□□□□□□□□□□1984□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□"Een natuurkundige beschouwing van ekologische problemen"□□□□□□□□□□□□□□

[9] □□Smil (2003) and Niele (2005)□

[10] Daviss (2007).

[11] McKenna (2008).

[12] □□□□□□□□□□□□□□□□□□□□□□□□□□□□E.F.□□□□E. F. Schumacher□1989□□□□□□□□□□□□□□□□□□□□□□□□□□□Small Is Beatiful: Economics as if People Mattered□□□□□□□□□□□□□□□□□□□□□□□□□□□□□

[13] □□□□□□□□□□□□□□Zapata & Roy (2004) and EcoSanRes (2008)□

[14] □http://science.nasa.gov/headlines/y2009/27may phantomtorso.htm□□□□□2009□5□□□□□□

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